TELEMATICS IN THE THIRD WORLD: THE IDRC EXPERIENCE

David A. Balson
Program Officer, Telematics

Information Sciences Division
International Development Research Centre
P. O. Box 8500
Ottawa, Canada K1G 3H9

Telephone: (613) 236-6163
Telex: 053-3753

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ABSTRACT

Computer-based messaging, bulletin-board, and conferencing systems are increasingly being used as computer and telecommunication technologies converge. With the exponential growth of information, especially in the scientific and technical domain, the need for effective and efficient methods for the transfer of information is becoming ever more pressing. These data communication techniques, non-real time and relatively low-cost in nature, can facilitate this information exchange. Recognizing these facts, the International Development Research Centre (IDRC) is developing a program of support for the promotion and use of these techniques in support of research activities in developing countries.

INTRODUCTION

Information gains value once it is exchanged or consumed. To be exchanged or consumed, it must be transferred or delivered. The need for effective and efficient means of carrying out this process is becoming ever more pressing with the exponential growth of information, especially in the scientific and technical domain, and with the increasing recognition of the importance of information to development. With the distinction between computer and telecommunication technologies disappearing, a number of communication techniques have been developed to facilitate this process and are increasingly being used in the world today.

These techniques are currently being explored in a number of projects supported by the International Development Research Centre (IDRC), a public corporation established by the Parliament of Canada in 1970 to stimulate and support scientific and technical research by developing countries for their own benefit. IDRC is somewhat unique among development aid agencies because it has stressed information sciences from the outset, in addition to its support for programs in agriculture, food and nutrition sciences, health sciences, and social sciences.(1) Within the Information Sciences Division at IDRC, programs provide support for: information systems and services within various sectors of importance to development, including socio-economic information and scientific and technical information; development and distribution of a database management software package (MINISIS) and other computer-based tools; operation of the Centre Library; and research and experimentation with different information technologies and methods for managing, storing, and retrieving this information and delivering it to its end users.

Within the latter Information Sciences Division program, known as Information Tools and Methods (ITM), support is provided for research and experimentation covering a variety of technologies and disciplines, including informatics, telematics, cartography and remote sensing, micrographics and other storage technologies, and statistical systems and methods. Activities supported include: information systems, networks, and services on specific technologies and methods; technology assessment, selection, evaluation, and testing; feasibility studies and technology demonstrations; pilot projects and experiments; technology introduction and transfer; technology adaptation and development; education and training; and documentation and exchange of experience.

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The focus of this paper is on the communication of information for development using modern data communication techniques and computer and communication technologies. Some of these techniques and technologies are described in the sections which follow, and several detailed case studies taken from IDRC's experience are summarized to illustrate them.

PACKET SWITCHING

These communication techniques are proliferating partly as a result of the implementation of packet switching networks and the resulting savings in cost and time.(2)

Packet switching was developed initially for interactive applications with computers (on-line retrieval). Communications sent by a terminal are broken into short packets with source, destination, and serial information attached to each packet. Packets are transmitted through nodes in the network by the most appropriate available route, and are retransmitted if acknowledgement of reception from any node is not received. The packets are then reassembled at the destination.

The network is shared by many users and bandwidth is not exclusively reserved for any one user. The result is more reliable, secure and speedy transmission of information with the cost based more on the quantity of information transferred rather than on time or distance.

On the international level, the national packet switching networks (Canada - DATAPAC, INFOSWITCH; USA - TYMNET, TELENET; France - TRANSPAC; Ivory Coast - SYTRANPAC; Gabon - GABONPAC; Malaysia - MAYPAC; etc.) are interconnected through international gateways (3) (United States - ITT, RCA, WUI; Canada - Teleglobe; Paris - NTI; London - IPSS; etc.). Every year more countries are establishing such links through these gateways. As this process continues the opportunities for reliable and relatively inexpensive data communication between any points on the globe will increase.

COMPUTER-BASED MESSAGING AND CONFERENCING: AN OVERVIEW

One of the most promising communications techniques to be used extensively since the beginning of this decade is computer-based messaging. In such systems, a user composes a message using a

computer terminal, and then transmits it, along with addressing information, to a computer via telecommunications links. The host computer, with appropriate software, manages the message electronically. When the addressee signs on to that computer, he or she receives delivery of the message, along with any others that are waiting. These systems are similar to telex but are much less expensive, and provide additional facilities such as upper and lower case characters, individualized formatting, forwarding of messages, automatic acknowledgement, multiple addressees for a message, and so on.

As an extension of this concept, systems designers developed what are now called computer-based conferencing systems (4), allowing many-to-many communications on specific topics. Such systems allow groups of people scattered around the world to discuss topics of common interest, such as scientific issues or administrative matters. The storage, retrieval, and processing capabilities of the computer, coupled with the appropriate software, permit the management and tracking of messages in a computer conference.

Perhaps the key characteristic of these systems is their asynchronous nature (senders and recipients communicate via the computer in non-real time). Certain advantages ensue as a result. Problems of communicating across time zones and some of the frustrations of making connections over the telephone disappear. One is able to participate in many electronic conferencing activities while at the same time conducting one's regular work. Individuals are able to ensure greater accuracy in their communications as they communicate while remaining close to their own data sources. In effect, the quality of communications is improved as individuals control the location, time, and rate of their communications. It has also been demonstrated that computer conferencing nurtures information transfers which would not have taken place with traditional means alone.

AN IDRC WORKSHOP ON COMPUTER-BASED CONFERENCING

It became evident at IDRC that these new communications techniques were being utilized more and more in the industrialized world, and there was concern that Third World institutions could be left out of the design, implementation, and use of the rapidly expanding networks. In order to explore the state of the art and receive advice on any potential role for donors, IDRC convened a week-long workshop in October 1981, entitled "Computer-Based Conferencing

Systems for Developing Countries".(5) It was perhaps indicative of the need for that workshop that only isolated pockets of activity in this field could be found in developing countries.

Experts from India, Brazil, international organizations involved in the informatics field, and those involved with existing systems discussed current and proposed systems, advantages and disadvantages, impediments to implementation, and possibilities for developing countries. The experts at the workshop were unanimous in stating that the greatest impediments to the implementation of international computer conferencing systems would be legal and regulatory, rather than technical.

It was the consensus of the workshop that these systems would be an integral part of the available communications options in the coming decade and that, unless the developing nations could participate in this electronic community of science and technology, they would suffer from disenfranchisement of a serious nature. This might take the form of a lack of access to the resources of the developed nations and the inability to gain timely access to results and techniques found in the developing countries themselves.

The participants in the meeting felt that there was a role for donors to play in this area and identified the need for a sufficient base of knowledge and experience related to these new information technologies.

Accordingly, within the Information Sciences Division of IDRC, a modest program in the area of telecommunication systems was established. More specifically, the focus of this program has been on data communications techniques in support of research activities. Its objective is to facilitate and support developing-country involvement in the testing, experimentation, development and use of these techniques in order that they can make more informed decisions on the appropriateness of these techniques for their needs.

THE COMPUTER CONFERENCE ON THE BIOCONVERSION OF LIGNOCELLULOSICS

One of the recommendations of the previously-cited Computer-Based Conferencing workshop was "that IDRC support a pilot CBCS [Computer-based Conferencing System] project involving both developed and developing nations". A suggested topic was the bioconversion of lignocellulosics (i.e. the conversion of waste

products into energy sources and nutrients), an appropriate area for international cooperative research given the obvious priorities of fuel and food to developing countries. With the acceleration of biotechnology research developments and the ever-growing gap between the resources available to industrialized versus developing-country researchers, the need for linkages to support the free exchange of ideas and information among them was becoming increasingly obvious.

Following from this recommendation and with the stimulus of Dr. C. G. Hedén of the Karolinska Institute in Sweden, IDRC began organizing a computer conference on "Bioconversion of Lignocellulosics for Fuel, Fodder and Food needed for Rural Development in Poor Countries". Over 100 researchers from many countries participated in this open, eight-month conference (which was held from May to December 1983), with the majority, as expected, participating from industrialized countries. Off-line participation modes were provided for those unable to participate on-line. The conference ran on two computer systems: Electronic Information Exchange System (EIES) at Newark, New Jersey and COM at Stockholm. Participation was via either EIES or COM and texts were transferred between the two systems. Following the conclusion of the conference, extensive evaluations sponsored by the United Nations University were carried out. The results of these were published by IDRC in 1985.(6)

From a technical perspective, this computer conferencing exercise was very useful, with the host systems and communications networks largely meeting the participants' requirements. As was anticipated, however, the central technical problem proved to be the difficulty (or in some cases impossibility) of gaining reliable access to the international data networks by scientists located in developing countries.

A number of conclusions can be derived from analysis of the technical aspects of this activity:*

(1) the host systems and data networks were generally reliable and facilitated participation, except for the difficulties generally experienced by participants from developing countries;

(2) expansion of access to international data networks from developing countries is essential if scientists in these countries are to be able to participate fully in future information exchange and transfer activities of this type;

* Extract from a contribution by J.B. Black to International Computer-Based Conference on Biotechnology: A Case Study.(6)

(3) equipment and facilities for participants (terminals, modems, microcomputers, software, communications links, etc.) must be close at hand if scientists are to integrate these activities into their normal research and scholarly communications process;

(4) ready access to good support systems for participants (training, manuals, "colleague advisors", etc.) is essential to the successful application of computer conferencing to research communications in the future.

It is interesting to look at the conference from the point of view of participants from a developing country. In order to participate on-line, researchers at the Instituto Centroamericano de Investigacion y Tecnologia Industrial (ICAITI) in Guatemala City had to overcome problems related to modems (standards), cables, and microcomputer communications software packages. Without local access to international data transmission networks, on-line participation, when finally possible, was expensive via regular voice channels. Despite these problems, these researchers felt that computer conferencing made sense, especially in light of high travel costs, the scarcity of foreign currency and related restrictions, and the future expansion of the international data transmission web. On the scientific side, certain benefits accrued from participation in the computer conference: their knowledge of current research activities was updated; they discovered research activities in laboratories new to them; they received confirmation that their research was on track; and they found some of the scientific discussions interesting and useful. As scientists in developing countries, they saw computer conferencing as an excellent tool for communicating ideas and exchanging know-how internationally.

Although participants from industrialized countries found the scientific content of the conference to be less useful than those from developing countries, in general, the technique of computer conferencing was accepted as a viable medium for facilitating scientific research. Of those participants who responded to a questionnaire, only 6% would not participate again in a computer conference on a subject of interest to them. Along with the advantages gained from having a written record, the inherent characteristics of asynchronous computer conferencing (i.e. participation at a time and rate of one's own choice, proximity to one's data sources, and being able to contemplate answers to questions before responding) were cited as the most important benefits.

For the developing-country participants, the greatest impediments to participation were related to access to terminals, reliable telecommunications links, access to the international data transmission networks, and the costs of participating. For the most part, participants from industrialized countries valued the exercise more for the experience in using computer conferencing rather than for the scientific discussions themselves. For them, drawbacks to this computer conference were predominately information related: too many repetitious comments, unwillingness of other participants to share new information, and lack of response to their contributions.

Perhaps the most valuable outcome of this activity has been the lessons learned concerning the use of computer conferencing. It seems apparent that this technique of communicating is best suited for dispersed groups working towards common goals with a need for regular communications. Convenient access to terminals and the existence of reliable telecommunications links is of course essential. To ensure greater participation of researchers in developing countries, improvement of the local telecommunications infrastructure and the encouragement of the expansion of the international data transmission networks will obviously be necessary. Although the Computer Conference on Bioconversion of Lignocellulosics was not a complete success, it did open a window on a new technology for a large group within the biotechnology community. But, being a relatively novel experiment, with an uninitiated user group, it served a very useful purpose in defining those areas which require further work.

CGNET: COMMUNICATIONS FOR AGRICULTURAL RESEARCH

The Consultative Group on International Agricultural Research (CGIAR) is an international consortium sponsored by the World Bank, the United Nations Development Program, and the Food and Agriculture Organization of the United Nations, dedicated to supporting research programs with the purpose of improving the quantity and quality of food production in the developing world. These programs are carried out by thirteen autonomous international agricultural research centres (IARCs).

In 1982, with conventional communications costs rising, budgets restricted or shrinking, the need for international scientific and administrative communications increasing, and the recent availability of a number of technical solutions, the CGIAR system decided that the time was appropriate to explore the technical, legal, administrative, and economic feasibility of the

implementation of a data transfer network for the IARCs. Two earlier studies had made initial recommendations, but for a variety of reasons these had not been pursued.

Following a meeting of CGIAR Centre Directors in 1982, a study was commissioned to look first at a system to handle inter-centre communications needs. During the first phase of the feasibility study, the consultants concluded that the primary services of a CGIAR data transfer network should be computer-based message services and gateway facilities from the computer-based messaging system to on-line database services. It was also determined that the prospects of a full implementation of a CGIAR data transfer network would be enhanced if a pilot project were established. Such a project would maintain and strengthen the momentum within the CGIAR system toward the implementation of new communications technologies. Since there were existent international computer-based messaging services, some, but not all, of the Centres could participate with relatively little outlay of resources. This would give the Centres and the associated Secretariats exposure to some of the practical problems and implications of establishing an operational system. They would have the opportunity to contemplate the managerial and financial implications resulting from the use of computer-based messaging services. As such, they would have a stronger basis for judging any eventual recommendation regarding full network implementation.

In addition, the consultants recommended that the original target group to be studied, the thirteen IARCs and two Secretariats, should be expanded to include some of the important remote research sites. As a result, a project was initiated to conduct a feasibility study on the implementation of a data transfer network for the CGIAR system which would include sites involved in a major share of information flow to and from the centres but which were not located at any of the 15 primary sites, and to establish, administer, monitor, and evaluate a small computer-based message system pilot project for the CGIAR system.

The project was completed in 1984, resulting in an operational network, CGNET (7), linking ten of the fifteen major sites along with some of their remote sites and many other institutions with which they conduct business and research.

The next logical step would be to expand the network to include those sites without ready access to the international data transmission networks. One of the IARCs, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in

Hyderabad, India, experimented during the project with participation in the network via a relay computer located in the United States. With this method, messages for ICRISAT were transferred to their computer via long-distance direct-dial telephone links; messages from ICRISAT left on the computer were then transferred onto the CGNET's manager's microcomputer during the same telephone call for later transferral to the CGNET host system through packet-switched connections. Even with this more complicated routing, ICRISAT became one of the system's heaviest users. Telex interfaces could also be employed on an interim basis by those institutions in countries without easy access until the time when the international network is more comprehensive geographically.

As CGNET matures, user groups will expand, applications will be tried and implemented if appropriate (including computer conferencing, bulletin boards, telex-refiling, database access, data transfer, etc.), and new locations will be added to the network. In fact, many of the difficult locations have been added since 1984 employing the relay method used for ICRISAT or via international direct dialing connections over the conventional telephone networks.

Projects such as this one can provide lessons which, although not novel, warrant mention. For the successful use of asynchronous communications networks, a critical mass of regular users is required to ensure that it is worthwhile for any one user to log on to the system. As with most technologies, training, both initial and ongoing, is probably the single most important investment. Related to training, with new information/communications technologies there appears to be a conditioning process required whereby resistance to change must be overcome. This can be accomplished by sensitization workshops, hands-on experience, encouragement by peers and supervisors, and the demonstration of effectiveness of the technologies. Finally, it is very difficult to implement a variety of applications of a technology simultaneously. A step-by-step approach is usually advisable. For each application, an individual with the appropriate technical, organizational, and personal skills, is required to blaze the trail.

PACSAT: PACKET SATELLITE COMMUNICATIONS

At the Computer-Based Conferencing workshop in 1981, one of the participants, Dr. S. Ramani of the Tata Institute for Fundamental

Research in Bombay, India, proposed the concept of a low-orbiting communications satellite dedicated to computer-based messaging for international development purposes. Dr. Ramani, in concert with Dr. R. Miller, who was then with Infomedia Corporation in the U.S., developed this concept into a full paper which was presented at the International Conference on Computer Communications in London, England in 1982.(8) The concept was well received. At approximately the same time, Dr. Yash Pal, Secretary-General of UNISPACE '82, stimulated by this, presented a document on the idea to the Secretary-General of the United Nations with the recommendation that the UN should explore such a satellite's applicability to its own operations.(9) One of the resolutions of the UNISPACE '82 conference also recommended pursuit of this concept.

Late in 1982, two groups, Volunteers in Technical Assistance, Inc. (VITA) and the Radio Amateur Satellite Corporation (AMSAT), in part sparked by this series of events, began a collaborative effort to demonstrate how an innovative low-cost communications satellite system based on packet-radio technology, called PACSAT (10), could improve the quality and speed of technical information transfer to and from developing countries. PACSAT would demonstrate the cost-effectiveness of using low-cost and relatively unsophisticated ground station technology while providing reliable high volume information transfer. Due to its independence from land-based telecommunications systems, PACSAT would open up communications links to previously inaccessible locations. Wherever the need for low-cost, timely, asynchronous, reliable information transfer on a local, regional, or global basis existed, PACSAT should be applicable. Regional information networks in locations where conventional communications media are poor or unavailable are obvious prime users of this technology.

PACSAT is planned as a small, low-earth orbiting satellite, covering every point on the globe at least twice daily. Acting as an "electronic mailbox", it will receive messages, store them and then deliver them to the intended addressee(s) at a later time. Real-time messaging will also be possible for ground stations which are simultaneously within the satellite's footprint. Connections between PACSAT and ground-based packet-switched networks will be available.

As part of this research effort, in March 1984, UOSAT-B, a satellite built by the University of Surrey in the United Kingdom, was launched carrying an experimental Digital Communications

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Experiment (DCE) which is a scaled-down version of PACSAT's "brains". In order to test the PACSAT concept in field conditions and to expose this technology to a wider audience, IDRC funded a Canadian non-governmental organization interested in this technology, Inter Pares, to manage a PACSAT experiment using the DCE at the Pacific Telecommunications Council's Conference (PTC '85) in Honolulu in January 1985.

Two-way communications exchanges had taken place in advance of this conference between stable environments at the University of Surrey and the home of the PACSAT project manager in Los Angeles. This was to be the first true field experiment. There were, of course, a number of technical difficulties and unanticipated problems. Furthermore, UOSAT-2 had not been originally designed for PACSAT-like applications, and certain accommodations had to be made for this. In the end, however, the demonstration was successful: messages were loaded into the computer on UOSAT-2 and others were received from both California and the University of Surrey, including one in response to a question loaded from Hawaii on the first orbit over Honolulu 100 minutes earlier. Since this experiment the DCE is now being used on a more continual basis for demonstrations and in some cases on a quasi-operational basis. IDRC is exploring possible support for pilot projects using the DCE.

Besides having exposed this concept to a wide audience, the technical team learned some valuable lessons concerning equipment requirements in the field and has started to incorporate these lessons in new hardware and software. For example, it is now expected that the electronic equipment, including the computer, will be transportable in a single airline carry-on bag. The antenna will be designed to be shipped in a tough plastic tube, which will also function as part of the mount.

PACSAT was to have been launched in the spring of 1987 via a "Get-Away-Special" on the US-NASA space shuttle. Subsequent events with the shuttle program have precipitated a search for other launch possibilities. AMSAT is responsible for the technical design, construction, testing and launch of the satellite while VITA is managing the administrative side (funding) and will provide test applications.

PACSAT represents a new information technology in the making. It is still at a very tenuous stage in its development, especially since much of the work is being done by volunteer labour. It is

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not even certain that all of the conditions will fall into place for its operation. But it does seem clear that it holds great potential for remote developing-country applications, and it is important to ensure that their needs are considered from the start.

In addition, there are certain problems associated with PACSAT: how to avoid legislative hurdles against its use over various countries; in what manner will particular user groups be able to avail themselves of this service; how can unauthorized use be prevented, and so on. These questions are being considered and solutions are being defined. On the other hand, with current studies showing the importance of telecommunications to development, the benefits to be gained from having access to alternative communications services appear to outweigh the difficulties involved.

OTHER IDRC ACTIVITIES IN TELEMATICS

Brief notes on several other activities are included to further illustrate this program.

The Telematics program at IDRC is developing in a step-wise fashion. When problems are identified in one activity, attempts are made to address them in subsequent activities. In the case of the computer conference on the bioconversion of lignocellulosics, the importance of focus with respect to the subject matter, the need for uniformity of purpose of the participants, and the necessity of adequate training, were highlighted by the evaluation and analysis of this activity. The program is now supporting a project that attempts to address these important factors. This project will allow the United Nations University to coordinate the implementation and evaluation of computerized links within a Latin American research network on the production of brucellosis vaccines and diagnostic reagents. The focus of this project is on producing useful knowledge regarding the effectiveness of computerized links for research networks. As a side benefit, this project will act as a demonstration project for other networks interested in the use of data communication techniques in support of research activities.

New information technologies are being rapidly adopted in Latin America. In addition, the use of data communications techniques is expanding. However, individuals and organizations wanting to employ these techniques are faced with a variety of questions: what is the most appropriate hardware/software combination; what

administrative requirements are set by the authorities; what are the correct protocols for communicating with different destinations; what are the costs; etc. Finding answers is usually only possible through trial and error. A project currently being supported has enabled the Instituto Latinoamericano de Estudios Transnacionales (ILET) in Santiago, Chile to study and experiment with a microcomputer-based communications network among nongovernmental organizations in Mexico, Brazil, Peru, Argentina and Chile. The project produced a manual and a detailed report to assist other organizations in implementing these techniques by providing answers, based on concrete experience, to the questions and problems related to effective utilization of new communications technologies.

The preceeding project complements another one involving a group of non-governmental research and documentation centres, either computerized or in the process of computerization, which have established a global network known as INTERDOC to provide the channels for the sharing of skills and knowledge on information handling techniques as well as for the sharing of primary and source information. This project will allow the International Documentation and Communication Centre (IDOC) in Rome, Italy to coordinate the development of this network. Information will be shared via computer-based communication techniques and also through the production and dissemination of a newsletter in both English and Spanish. By supporting the growth and strengthening of the INTERDOC network through improved communication among members and the sharing of information and resources, more effective and efficient operation of approximately 30 non-governmental organizations (NGOs) will be facilitated. This will result from the implementation of more efficient information-handling systems, the adoption of standards to ensure greater compatibility among systems, the provision of on-line training and answers to questions for those organizations able to participate through data communication channels, and the exchange of data and documents. Although the network members themselves will be the immediate beneficiaries of the results of the project, the products will by no means be limited to that group, but will be equally applicable and useful to other groups with a mandate to provide information services. Of course, the ultimate beneficiaries will be the client communities the INTERDOC member organizations are serving.

The project coordinated by ILET has helped to stimulate a considerable increase in the level of activity in networking in its region. As a logical follow-on, a second phase will test and

evaluate more sophisticated communication software packages, based on current human/organization communication theories, within a Latin American trade information network and a South-North telecommunications technology transfer network. As part of these experiments, various training methodologies will be developed and evaluated. The project will result in expanded awareness, understanding and use of these systems, the availability of training models, a technical report on the telephone and data communication systems in Latin America and strengthening of network facilitators.

Following successful results from this type of activity, discussions are underway to replicate them in both Asia and Africa. The common element involves the identification of an appropriate institution (in these cases, non-governmental) interested in seeing data communication techniques more widely utilized. These projects will sensitize organizations and institutions in their regions, identify and train network facilitators, develop and test various networking modalities and encourage information generation and dissemination on the topic of data communication-based networking.

In Tunisia, the Centre National de l'Informatique is being supported to develop and experiment with a bilingual (French/Arabic) messaging system based on the CCITT X.400 standard for the interconnection of messaging systems. They will be utilizing the EAN software developed by the Unviersity of British Columbia. The system will be developed for use by the Tunisian research community and will be accessible via packet-switched networks, the regular telephone network and telex.

Although the Telematics Program has supported very little in the area of basic infrastructure development, it is supporting a feasibility/design study with respect to the implementation of a packet switching network in Burkina Faso. This assistance is viewed as a potential stimulant to the expansion of the international data network web.

CONCLUSIONS

The examples given in this paper relate to new information technologies and tools at relatively early stages in their development and application, especially with respect to developing countries. The evidence which they provide is by no means

conclusive, either in absolute terms related to the ultimate utility of the technologies involved or in relative terms related to the appropriateness for developing countries. Although these activities have been carried out, in part, to ensure that the interests of developing countries are considered at the early stages in technology development, clearly there is further testing to be done. However, basic information and experience have been gained to enable better planning by developing countries.

New technologies and tools bring with them an immensely complex range of issues -- social and economic, as well as technical. Developing countries are demanding relevant information upon which to base their decisions. The need for experimentation, open discussion, and information dissemination has never been greater. That is why organizations like IDRC support initiatives such as those described in this paper; even if they do not always succeed or provide the best solution, at least they have been tested, and with developing countries in mind.

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